2010

The Effects of Positioning on Premature Infant Development

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Date: **November 2010**

CLINICAL SCENARIO:

It is inevitable that premature infants in incubators will lie with all limbs flattened against the mattress in external rotation as a result of gravity; this forced positioning has been shown to lead to early hip deformities (Vaivre-Douret, Ennouri, Jrad, Garrec & Papiernik, 2004). In infants, muscular abnormalities develop quickly and the longer these deformations and non-functional body positions are allowed to persist, the more difficult they will be to correct (Vaivre-Douret, et al., 2004; Vaivre-Douret & Golse, 2007). Without preventative positioning, preterm infants can acquire postural deformations which can limit future development through decreased body movement, thereby limiting exploration of the infant's environment and decreasing learning experiences (Vaivre-Douret & Golse, 2007; Barradas, 2006). Positioning premature infants in ways that promote development and the eventual engagement in occupations is a domain of concern to occupational therapy and an avenue for occupational therapy research and education.

FOCUSED CLINICAL QUESTION:

How does positioning affect the development of premature infants?

SUMMARY of Search, 'Best Evidence' appraised, and Key Findings:

- *Five articles were found that address the focused clinical question.*
- *The randomized control trial (RCT) by Vaivre-Douret, Ennouri, Jrad, Garrec and Papiernik (2004) has been considered the best evidence to provide insight to the focused clinical question.*
- *The RCT investigated short-term effects of varied lying positions on premature infants and evaluated their effect in preventing neuromuscular and postural abnormalities.*

CLINICAL BOTTOM LINE:

Correct body positioning can likely prevent physical and neurological abnormalities in preterm infants (Vaivre-Douret & Golse, 2007). More research needs to be done in this area to define the best positioning methods for the best developmental outcomes.

Limitation of this CAT:
The critically appraised paper has been individually prepared by a master's of occupational therapy student as part of a university project and reviewed by a faculty member, but has not been externally peer-reviewed.

SEARCH STRATEGY:

Terms used to guide Search Strategy:

- **P**atient/Client Group: Premature infants
- **I**ntervention (or Assessment): Positioning
- **C**omparison: Experimental vs. standard positioning
- **O**utcome(s): Development

Databases and sites searched	Search Terms	Limits used
Ovid Medline 9.14.10	Positioning AND premature infants AND sensory	Limited to humans, English only and full-text articles, 3 articles retrieved
Ovid Medline 9.14.10	Premature infants AND sensory stimulation AND positioning	Limited to humans, English only and full-text articles, 3 articles retrieved
Ovid Medline 9.14.10	Premature infants AND occupational therapy AND position	Limited to humans, English only and full-text articles, 2 articles retrieved
Ovid Medline 9.16.10	Positioning AND premature infants AND development	Limited to humans, English only and full-text articles, 31 articles retrieved
Ovid Medline 9.16.10	Positioning AND premature infants AND child development	Limited to humans, English only and full-text articles, 33 articles retrieved

INCLUSION and EXCLUSION CRITERIA

- Inclusion:
  - Premature infants
  - English language only
  - Full-text articles only

- Exclusion:
  - Articles older than 10 years

RESULTS OF SEARCH

Table 1: Summary of Study Designs of Articles retrieved

Study Design/ Methodology of Articles Retrieved	Level	Number Located	Author (Year)
Randomized control trial	**1b**	**3**	Vaivre-Douret, L., Ennouri, K., Jrad, I., Garrec, C. & Papiernik, E. (2004) Maguire, C. M., Walther, F. J., Sprij, A. M., Le Cessie, S., Wit, J. M. & Veen, S. (2009) Barradas, J., Fonseca, A., Guimaraes, C. L. N. & Lima, G. M. de S. (2006)
Prospective cohort	**2**	**1**	Vaivre-Douret, L. & Golse, B. (2007)
Case-control	**3**	**1**	Grenier, I. R., Bigsby, R., Vergara, E. R. & Lester, B. M. (2003)

BEST EVIDENCE

The following study was identified as the 'best' evidence and selected for critical appraisal. Reasons for selecting this study were:

- **The study measured outcomes in a variety of areas (muscle tone and reflex, behavior, visual/auditory function, sensory-motor skills, postural control and orthopedic lower limb position)**
- **Quality and rigor of the statistical data**
- **The study provided information to most effectively answer the focused clinical question**

SUMMARY OF BEST EVIDENCE

Table 2: Effect of Positioning on the Incidence of Abnormalities of Muscle Tone in Low-risk, Preterm Infants by L. Vaive-Douret, K. Ennuri, I. Jrad, C. Garrec & E. Papiernik (2004).

Aim/Objective of the Study:

To investigate the short-term effects of varied lying positions on premature infants and evaluate their effect in preventing neuromuscular and postural abnormalities.

Study Design:

Randomized control trial

The study procedure for the experimental group consisted of changing the lying position of a preterm infant randomly between front, back and side positions, while maintaining physiologically functional positions. The control group of preterm infants received the standard care provided in the hospital. Randomly numbered examination tables were used to set up two randomized groups (treatment and control). Randomization was separated by gestational age at delivery into two groups: 31-33 weeks gestation and 34-36 weeks gestation. Infants were differentiated into two groups because of maturation differences that would occur due to age differences.

Outcomes were measured within the first week after birth and at the time of discharge from the hospital.

Setting: Hospital neonatal unit

Participants:

Treatment N=30; control N=30

Inclusion criteria: infants between 31-36 weeks gestational age without congenital or genetic neurological anomalies and having a normal cranial ultrasound.

Exclusion criteria: infants who had initially received treatment in an intensive care unit, an infant from a multiple birth (triplets or above), an infant from a breach delivery, infants with deformities of prenatal origin (fractures, subluxation), genetic abnormalities,

hereditary diseases, neurological abnormalities detected within the first week of life, infants who received mechanical ventilation, refusal from the parents to continue the study, or referral of the infant to another department during convalescence.

No significant differences existed between the control and treated groups. All infants were born at the same hospital and directly admitted to the neonatal unit.

Initially, 62 infants were recruited, but two of them were transferred to another neonatal center and dropped from the study.

All infants participated in both outcome measurement examinations.

Intervention Investigated:

Control: Nursing staff positioned control group infants in a prone position, according to the standard of care current for the time, 1994. A small bolster made of hand-rolled sheets was used to raise the pelvis without flexing the hips to more than 90 degrees, ensuring no external rotation or adduction of the legs.

Experimental: Nursing staff repositioned the infants every 3-4 hours and were instructed to vary the lying positions equally. Infants were placed on a moldable mattress while lying on their side or back only. The mattress supported the infant in lateral decubitus by molding around the rear of the body to support the head in line with the trunk. When the infant was on its back, the mattress was shaped to hold the shoulders back while keeping the knees bent forward. The hospital supplied bolster was placed under the hips when lying in prone.

Outcome Measures:

Outcome areas measured were neurological and psychomotor. The first examination was performed within the first week after birth and included both the neurological protocol and only the orthopaedic lower limbs examination of the psychomotor assessment due to the infants' immature age. The second examination, performed at the time of discharge from the hospital consisted of the full neurological and psychomotor protocols because the coordination required to complete the tests was now present due to infant aging.

The neurological examinations of both groups were conducted by the same pediatrician throughout the study. The psychomotor examinations of both groups were conducted by a psychomotor therapist who was trained by one of the study's authors. Infants were

brought to examiners in a separate area, so the examiner was blind to the infants' group assignment.

Neurological measure:

Consisted of muscle tone and primitive reflex examinations based on methods of Andre-Thomas and Saint-Anne Dargassies, Amiel-Tison and Grenier, Prechtl and Beintema, and Brazelton in order to assess neurological maturation. Scoring was based on ocular motor items, passive muscle tone (axial, arms, and legs), active muscle tone and primitive reflexes.

Psychomotor measure:

Included assessment of behavior, visual/auditory function, sensory- motor skills, postural control and orthopedic lower limb position. Protocols included norm-referenced scores for each category.

Main Findings:

Neurological:

Table 3 Comparison between control and treated groups for the passive tone data for the main axis of the body.

	Treatment group ($n = 30$) n (%)	Control group ($n = 30$) n (%)	χ^2	p
Trunk extension/flexion				
Normal (extension = flexion)	29 (97%)	14 (47%)	18.5	0.01
Exaggerated (extension = flexion)	1 (3%)	16 (53%)		
Opisthotonos (extension of head and trunk)				
Absent	29 (97%)	13 (43%)	20.3	0.01
Induced	1 (3%)	17 (57%)		
Extension of the forearm				
Complete	30 (100%)	24 (80%)	6.67	0.01
Incomplete	0	6 (20%)		

Table © 2004, European Journal of Paediatric Neurology. Reproduced from: Vaivre-Douoret, et al. (2004). Effect of positioning on the incidence of abnormalities of muscle tone in low-risk, preterm infants. *European Journal of Paediatric Neurology, 8*, 21-34. doi: 10.1016/j.ejpn.2003.10.001.

Psychomotor:

Table 4 Abnormalities (%) with ORs from the psychomotor assessment protocol of the whole population.

	Population ($N = 60$)				
	Treatment ($n = 30$) n (%)	Control ($n = 30$) n (%)	OR (95% CL)	χ^2	p
Assessment of behavior					
Normal	21 (70%)	11 (37%)	0.25 (0.085–0.73)	6.7	0.01
Moderate deviation	9 (30%)	19 (63%)			
Visual and auditory function					
Normal	28 (93%)	18 (60%)	0.11 (0.02–0.55)	9.3	0.01
Moderate deviation	2 (7%)	12 (40%)			
Sensory-motor skills					
Normal	26 (87%)	3 (10%)	0.017 (0.003–0.084)	35.7	0.01
Moderate deviation	4 (13%)	22 (73%)			
Major deviation	0	5 (17%)			
Postural control					
Normal	27 (90%)	1 (3%)	0.0038 (0.00037–0.039)	45.5	0.01
Moderate deviation	3 (10%)	23 (77%)			
Major deviation	0	6 (20%)			
Orthopaedic lower limbs					
Normal	25 (83%	11 (37%)	0.12 (0.04–0.4)	13.6	0.01
Moderate deviation	5 (17%)	19 (63%)			

CL indicates confidence interval.

The largest difference between the two groups, treatment and control, was in postural assessment (20% of control group scored major deviation from norm vs. 0% in treatment group). The next most severely affected assessment was that of sensory motor skills (17% of control group scored major abnormality from norm vs. 0% in treatment group). Behavioral and orthopedic assessments were moderately affected (63% of control group scored moderate deviation from norm vs. 30% and 17%, respectively, in the treatment group). Visual and auditory function assessments were the least affected between the two groups (40% of control group scored moderate deviation from norm vs. 7% in treatment group).

Original Authors' Conclusions:

The study concluded that regular changes in the positioning of premature infants, while retaining correct functional positions (ex. knees held forward and lower than the pelvis and head supported in midline), decreased the incidence of neuromuscular and osteo-

articular abnormalities, which promotes the eventual development of functional motor activities. When infants are placed in a single position for a long time period, muscular shortening quickly develops, which disrupts functional motor organization.

Critical Appraisal:

Validity

- Rationale, reliability and validity of the assessments used in the above study were previously established in two earlier articles and, because of length, have been excluded here and in the study itself (Vaivre-Douret L., 1997a; Vaivre-Douret, L., 1997b).
- Approval for the study was received from an Internal Review Board and consent was obtained from all parents at the time of enrollment in the study.
- All infants in the study were born at the same hospital, which could introduce bias if the hospital tends to serve one population over another, or is a private versus a public hospital, receiving different funding support.
- Eligibility criteria: Inclusion and exclusion criteria were clearly defined.
- Randomization: Infants were separated into randomized groups by gestational age, 31-33 weeks or 34-36 weeks due to maturation differences that would occur due to age. Both age groups were randomized.
- Allocation was concealed: The report does not explicitly state whether the assignment of infants into the treatment or control group was known at the time of enrollment into the study.
- Groups were similar at baseline: No significant differences existed between subject groups prior to treatment.
- Blinding of subjects: Because the subjects were infants, they were naturally blind to their assignment.
- Blinding of therapists (nurses): The authors did not state whether different groups of nurses cared for the different infant groups, or if the nurses were blind to the infants' group assignment. Because the nurses were in charge of positioning and recording the re-positioning of the infants, it could be assumed they were aware of the infants' group assignments.
- Blinding of assessors: Examiners were blind to the infant's group assignment.

- Measures were obtained from at least 85% of subjects: All infants participated in both outcome measurement examinations.
- Intention to treat: All infants either received experimental or control treatment.
- Results of between-group statistical comparisons: Results between the treatment and control groups were reported for all neurological and psychomotor measures.
- Point measures and measures of variability: Differences in group outcomes and confidence intervals were reported in the study findings.
- PEDro scores are used to assist researchers in finding studies that are more likely to be valid and that contain sufficient information to guide clinical practice.
- The study received a PEDro score of 9/11, not meeting the criteria for concealed allocation and blinding of the therapists (nurses) who administered the treatment (varied positioning).

Interpretation of Results:

The results of the study and outcome measurements favored the treatment group. Sensory-motor skills examinations showed significant abnormalities in the control group. Control group infants also exhibited excessive muscular extension of the posterior axis of the body. This would eventually restrict movements such as rolling over and sitting up with arm support. Psychomotor and neurological examinations of both groups showed delayed developmental muscular acquisitions for control group infants. Results for the neurological and psychomotor measurement findings were statistically significant with $p = .01$.

The differences between groups were clinically meaningful in that the treatment showed that in can decrease the occurrence of some of the neurological and psychomotor abnormalities that are seen when standard care is given.

Summary/Conclusion:

Regular changes in a premature infant's posture may have a beneficial effect on development that is shown in a better response to psychomotor and neurological assessments, less excitability, and movements that are easier to elicit. Abnormal muscle tone, as seen in the control group, interferes with behavior control, which could cause over-excitability and difficulty in consolibility. Promoting a functional posture in these infants is a mean of promoting correct psychomotor and neurological

development.

Table x: Characteristics of included studies

Study	Summary of the Research Study
Comparative Effects of 2 Positional Supports on Neurobehavioral and Postural Development in Preterm Neonates by L. Vaivre-Douret & B. Golse (2007)	**Purpose:** To assess the effects of two different lying-position body supports, the Coconou and Home Cocoon, in the development of behavioral responsiveness and in preventing head flattening and muscular contraction abnormalities. **Participants:** Infants born between 28-35 weeks gestational age with no congenital malformations, genetic abnormalities or central nervous system disturbances, and were breathing room air at 5-6 days of age. Home Cocoon N = 14; Coconou N =13. **Intervention:** The control group of infants received the standard level of care, using the Home Cocoon support. This support consisted of rolled up sheets positioned by nurses, with the support close to the infants' arms and trunk, while lifting the knees to maintain hip flexion. When in side lying, the rolled up sheet was placed behind the back and between the legs. The treatment group of infants received care using the Coconou support. This support was made of flexible and adjustable pads designed to ensure body support when in different lying positions, such as in supine to reduce shoulder and hip abduction, maintain knee elevation, prevent head flattening, maintain a midline head position, and hold shoulders forward to encourage hand to mouth movements. It was also designed to allow for spontaneous movement by the infant. All infants received positional support for a full 24 hours and were

	predominantly placed in a supine position. **Outcome:** Overall, the Coconou group received better scores than the Home Cocoon group on outcome measures of body posture and motor behavior. A significant difference was found in using the Coconou support versus the Home Cocoon in maintaining appropriate positioning to promote normal postural development.
Relationship Between Positioning of Premature Infants in Kangaroo Mother Care and Early Neuromotor Development by J. Barradas, A. Fonseca, C. L. N. Guimaraes & G. M. de S. Lima (2006)	**Purpose:** To identify the neurological and psychomotor implications associated with placing premature infants in a prone or lateral decubitus position during Kangaroo Mother Care (KMC). **Participants:** Infants between the ages of 32 and 40 weeks at the time of admission to the KMC unit having clinical stability, total enteral nutrition (breast, gastric tube, or cup) and a minimum weight of 1250 grams, and without periventricular hemorrhage (grades III or IV), moderate or severe hypoxia, Apgar scores of less than 7 at 5 minutes after birth, and birth weight of less than 1000 grams. **Intervention:** One group of infants was placed in prone position (PP), the other placed in lateral decubitus (LD), while in their kangaroo binders or cribs. The study did not specify who delivered the positioning or how often positioning or long positioning occurred for. **Outcome:** Placing infants in an LD position possibly has significant benefits for neuromotor development. Infants in the LD group showed significant improvement in 13 out of 16 items on a neurobehavioral assessment, while the PP group had significant improvement in 5 out of 16 areas in the same assessment. Overall, the LD group

	had better flexor tone and head control than the PP group. The LD group also had a higher rate of twisting at the trunk, which uses the body's major muscle groups and positions the infant in a way that favors motor coordination. Infants placed in PP showed more extension of the body, which is contrary to the direction of the physiological curvature and may have significant implications on an infant's biomechanical development.
Effects of Individualized Developmental Care in a Randomized Trial of Preterm Infants <32 Weeks by C. M. Maguire, F. J. Walther, A. M. Sprij, S. Le Cessie, J. Wit & S. Veen (2009)	**Purpose:** To investigate the effects of the Newborn Individualized Developmental Care and Assessment Program (NIDCAP) on days of respiratory support and intensive care, growth, and neuromotor development at term age (40 weeks) for infants born at less than 32 weeks. **Participants:** Infants with a gestational age of less than 32 weeks and without major congenital anomalies, a need for major surgery, and having a drug-addicted mother. NIDCAP N = 81; control N = 83. **Intervention:** Control group infants received basic developmental care including incubator covers, nests and positioning aids. Treatment group infants received weekly behavioral observations by certified NIDCAP developmental specialists and individualized care plans providing parental education on infant behavior and how to support and care for the infant. These infants also received incubator covers, nests and positioning aids to encourage flexion and containment. The nurses who cared for treatment group infants received extra training in behavior-based, individualized developmental care and were familiar with performing individualized care. **Outcome:** There were no significant differences in days

	spent in intensive care, days on respiratory support or growth between NIDCAP and control group infants. There were also no significant differences between the NIDCAP and control groups in neurobehavioral outcomes or growth parameters at term age, in daily weight gain, or in weekly length and head circumference growth. Regarding the finding that there were no significant neurobehavioral outcomes, the study authors mention that two previous NIDCAP studies did show significant improvement in this area when using the same assessment (Prechtl method). The lack of neurobehavioral differences found in this study could possibly be due to infants receiving the same positioning protocol (this study did not discuss how infants were positioned.
Comparison of Motor Self-regulatory and Stress Behaviors of Preterm Infants Across Body Positions by I. R. Grenier, R. Bigsby, E. R. Vergara & B. M. Lester (2003)	**Purpose:** To examine whether a relationship exists between preterm infant position and the frequency of motor-based self-regulatory (i. e. active efforts to regulate autonomic functions, motor control and states of arousal) and stress behaviors. **Participants:** N = 15. Infants born between 23 and 30 weeks gestation without congenital anomaly, active sepsis at the time of assessment, parents under investigation by the Department of children, Youth and families, or mother with a psychiatric diagnosis. **Intervention:** Infants had already been videotaped during non-caregiving (resting) periods for a previous study. Each videotaped infant observation was examined during baseline (a period 10 minutes before caregiving) and recovery (a period 10 minutes immediately after caregiving) for self-regulatory or stress

	behaviors and while the infant was in one of six positions (prone nested, prone un-nested, side-lying nested, side-lying un-nested, supine nested and supine un-nested). Self-regulatory and stress behavior definitions were based on those used in previous studies. **Outcome:** There was a statistically significant relationship between infant position and self-regulatory and stress behaviors. The side-lying un-nested position showed to be the position where the highest number of self-regulatory behaviors occurred; the fewest number occurring in the prone nested position. The highest number of stress behaviors was seen in the side-lying un-nested position; the lowest number was seen in the prone nested position. The study found that the prone position is most favorable, with prone un-nested and side-lying nested positions coming in second, for improved state of arousal control (based on occurrence of self-regulatory and stress behaviors) in preterm infants.

Implications for Practice: Through positioning recommendations, occupational therapists can possibly facilitate an infant's improved ability to self-regulate, thereby benefitting infants by promoting calm sleep states and conserving energy for growth (Grenier, Bigsby, Vergara & Lester, 2003). Using a full-body postural support for positioning may provide a means to reduce postural and orthopedic abnormalities for preterm infants or any infant that must be confined to their bed for a long time period (Vaivre-Douret & Golse, 2007). Overall, these studies make significant cases for positioning infants in supine or lateral decubitus positions to increase psychomotor and neurobehavioral outcomes and in prone or lateral decubitus positions to improve self-regulation (Barradas, 2006; Grenier, 2003; Vaivre-Douret, 2004 & 2007).

Implications for Education: Depending on the setting, it is the occupational therapist that works with a preterm infant, making positioning recommendations to optimize development, yet there is little information to support this or add knowledge to this practice, especially specific to occupational therapy (Grenier et al., 2003). Implications of this research serve to bring the subject to the attention our profession and show that this topic is within our scope of practice. Therapists working in pediatrics, as well as entry level students, need to be educated about development, how development can be affected, and enhanced, and how early development affects outcomes later in life. This research also serves as an educational guide to neonatal practice and the importance of early development in premature infants (Vaivre-Douret, et al., 2004).

Implications for Future Research: All reviewed studies stated that more research needs to be done regarding positioning of preterm infants for optimal developmental outcomes, larger sample sizes should be used and long-term effects of treatment need to be studied. This body of existing research serves as a good starting point to furthering the knowledge base, allowing new studies to fill in knowledge gaps, and increase outcomes of preterm infant development. Conducting research in this area is a delicate matter because the subjects are fragile preterm infants, so it will remain extremely important that any control group receive at least the current standard of care and that the best interest of the infants is always in the forefront of a researcher's mind.

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